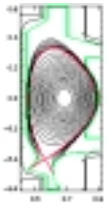
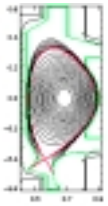
Research Plans



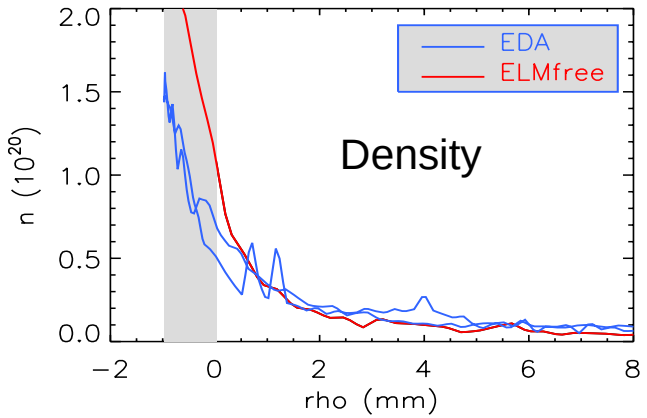
- C-Mod research organized around 6 topics
  - Transport
  - Edge/Divertor
  - MHD
  - RF Heating, Current and Flow Drive
  - Basis for next step burning plasma options
  - Integrated Advanced Tokamak

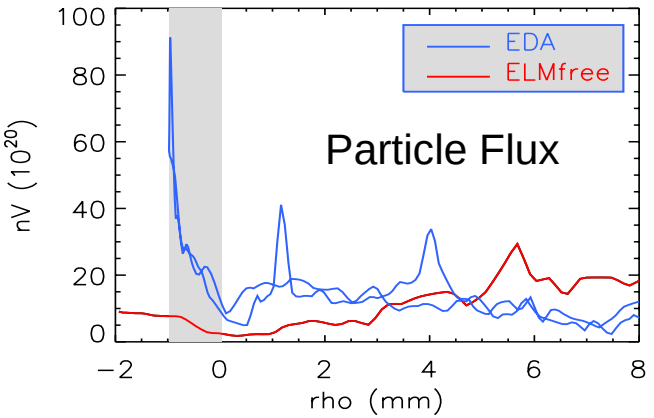
Transport Physics



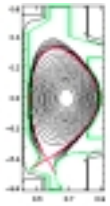
- Enhanced D-Alpha H-Mode
  - Experiments and modeling
- H-Mode Pedestal Physics
  - High resolution diagnostics
- H-Mode Threshold
  - Local param. dependence
- Internal Transport Barriers
  - H to L back-transition
  - PEP mode
  - Current ramps
- Transport induced rotation
  - Seen in ohmic H-Modes as well as RF heated plasmas

Probe measurements show that coherent mode drives particle transport in EDA H-mode



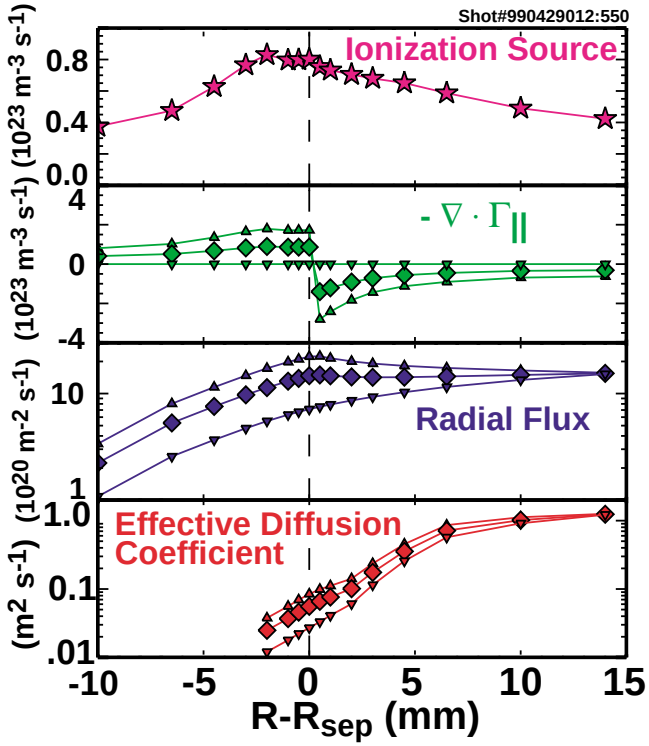


Edge/Divertor Studies

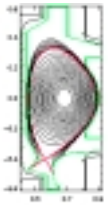


- Particle Recycling
  - Main chamber recycling dominates under most conditions
  - Important implications for particle and ash control
- Doubling Input Power
  - 1 GW/m^2 parallel flux in scrapeoff
- Density Control
  - Critical for LHCD AT program
- Impurity Control
  - High Z first wall

Cross-field particle transport increases strongly in the scrape-off layer, resulting in enhanced main chamber recycling

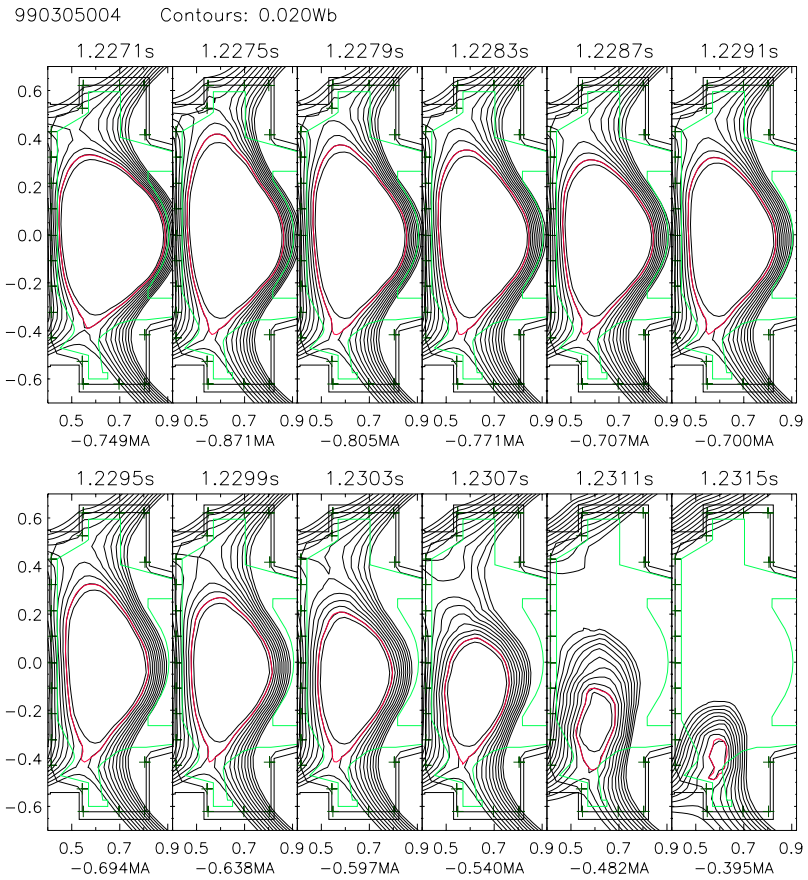


MHD Studies

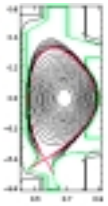


- Edge Barrier Stability
  - In EDA H-Mode, don't see large, discrete (type I) ELMs, in spite of exceeding first stability limit
  - Investigate effects of increasing pressure gradient
- Disruption Neutral Point
  - Collaboration with JT60-U
  - Enhanced vertical stability
  - More time for killer pellets
  - Enough time for PF system to stabilize and avoid VDE?
- Disruption Forces
  - Detailed measurements of inner wall deflection

If positioned near the neutral point, the plasma remains near midplane for several ms after thermal quench



ICRF

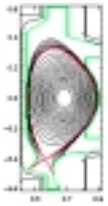


- Heating
  - Doubling input power to 8MW source
  - Minority and mode-conversion scenarios with 4 MW at 80 MHz plus 4 MW tunable 40-80 MHz
  - Benchmark TORIC code to develop predictive capability
- Mode Conversion Current Drive
  - Can be applied on- or off-axis
  - Sawtooth suppression, High l_i
  - Core barrier maintenance
- IBW Mode Conversion Flow Drive
  - Transport barrier control

Testing Boron-Nitride Protection Tiles on one Dipole Antenna

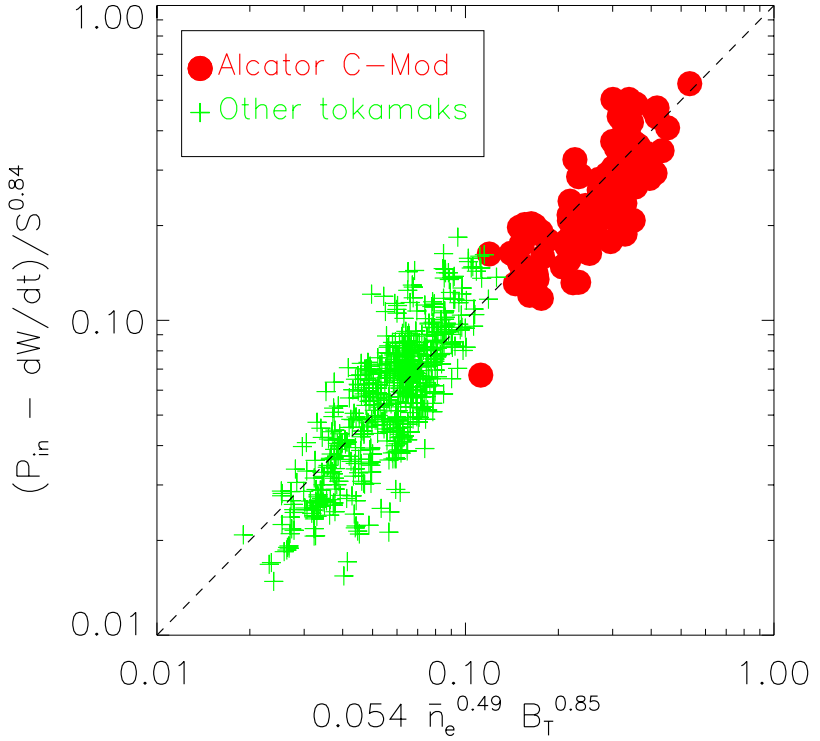
We have evidence that RF sheath rectification plays a role in impurity generation

Physics Basis for Burning Plasma NSO's

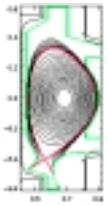


- C-Mod Prototypical of Compact Burning Plasma Experiments
  - 9 Tesla, RF driven, $T_i = T_e$
- Outstanding Issues
  - Confinement
  - H-Mode threshold
  - Power Handling
  - Density Limits
  - Tritium retention
  - Disruption forces

C-Mod Extends the H-Mode Threshold Database by about 1 Order of Magnitude in Power/Surface Area

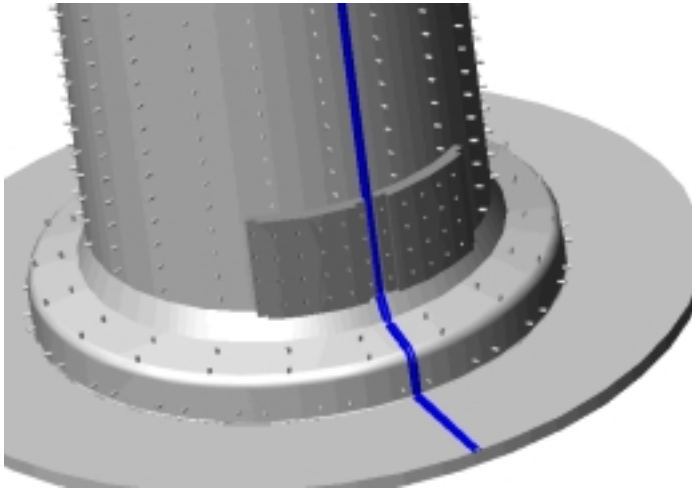


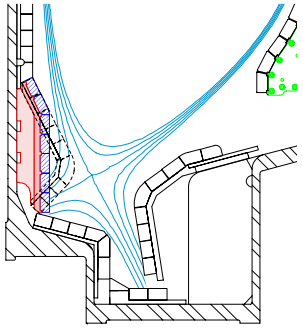
Upgrades



- Extensive diagnostic upgrades implemented in previous year
  - High resolution edge profiles and fluctuations
  - Core profiles
- DNB installed
  - Associated diagnostics: CXRS, BES, and MSE
  - Improved T_i and rotation measurements
  - Core fluctuations
  - Current density profile evolution
- Inner wall/divertor modifications
  - Shape flexibility and inner wall strengthening

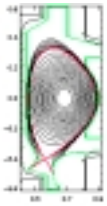
Inner wall will be strengthened for 2.5 MA operation at 9 Tesla





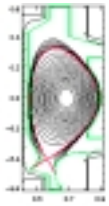
Inner divertor will be flattened to allow higher triangularity

Upgrades for AT Program



- Long Pulse Power Supply Upgrades
  - Minor modifications required for 5 second operation
  - Systems tests (with plasma) scheduled
- Density Control
  - Experiments underway
  - Cryopump system needed for quasi-steady-state
- Modifications to ICRF antenna faraday screen may be needed for t > 2 s
- Lower Hybrid Current Drive

Alcator C-Mod Guidance Budgets



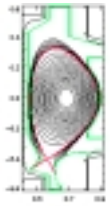
MIT	FY00	FY01A	FY02A
Research	4,795	4,696	4,716
Facility Operations	9,391	8,409	8,991
Lower Hybrid	822	1,014	835
Total	**15,008**	**14,119**	**14,542**

PPPL C-Mod Collaboration	FY00	FY01A	FY02A
Research	1,909	1,554	1,671
Operations	204	106	114
Lower Hybrid	301	602	478
Total	**2,414**	**2,262**	**2,263**

U. Texas C-Mod Collaboration	FY00	FY01A	FY02A
Research	756	717	739
Operations	284	269	277
Upgrades	44	41	42
Total	**1,084**	**1,027**	**1,058**

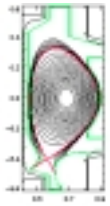
Grand Total	**18,506**	**17,408**	**17,863**

Consequences of Guidance Budget Cuts FY2001



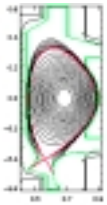
- Run time reduced to ~12 weeks
- Lower Hybrid project slowed
  - Phase I delayed and second launcher deferred
- Power supply upgrades deferred to 2002
  - Required for quasi-steady-state operation
- Important diagnostic upgrades deferred
- Cryopump deferred
- Staff reductions
  - Mechanical and RF engineering operations support weakened

Consequences of Flat Budget at 2001A level through 2002



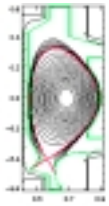
- Routine inspection of Alternator required in 2002 ($750k)
- Maximum run time of 12 weeks
- Significant delay in completion of Lower Hybrid base project (~6 months)
  - Impossible to start second LH launcher
- Further staff layoffs: scientific, engineering and technical staff, including support for external use of MDSplus
- Long pulse upgrades deferred to 2003
- Diagnostic maintenance deferred
  - Important information will likely be lost
- Obsolete computing resources will not be replaced
- Tokamak control system upgrade deferred
  - Jeopardizing operations reliability

FY02A Personnel Reductions



- Under the guidance budgets, personnel reductions in FY2002 (relative to FY2000) will impact all aspects of the program
  - 3 Engineering and Computer Staff
  - 2 Technical Staff
  - 1 Scientific Staff
- Collaborators will also suffer staff reductions

Incremental Budgets



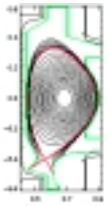
MIT	FY00	FY01B	FY02B
Research	4,795	4,987	5,153
Facility Operations	9,391	9,721	10,453
Lower Hybrid	822	1,171	1,008
JET Collaborations		204	201
Total	**15,008**	**16,083**	**16,815**

PPPL C-Mod Collaboration	FY00	FY01B	FY02B
Research	1,909	1,554	1,670
Operations	204	106	114
Lower Hybrid	301	903	779
Total	**2,414**	**2,563**	**2,563**

U. Texas C-Mod Collaboration	FY00	FY01B	FY02B
Research	756	803	827
Operations	284	301	310
Upgrades	44	46	47
Total	**1,084**	**1,150**	**1,184**

Grand Total	**18,506**	**19,796**	**20,562**

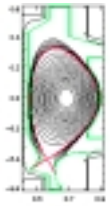
Incremental Budgets Enable a Healthy Program

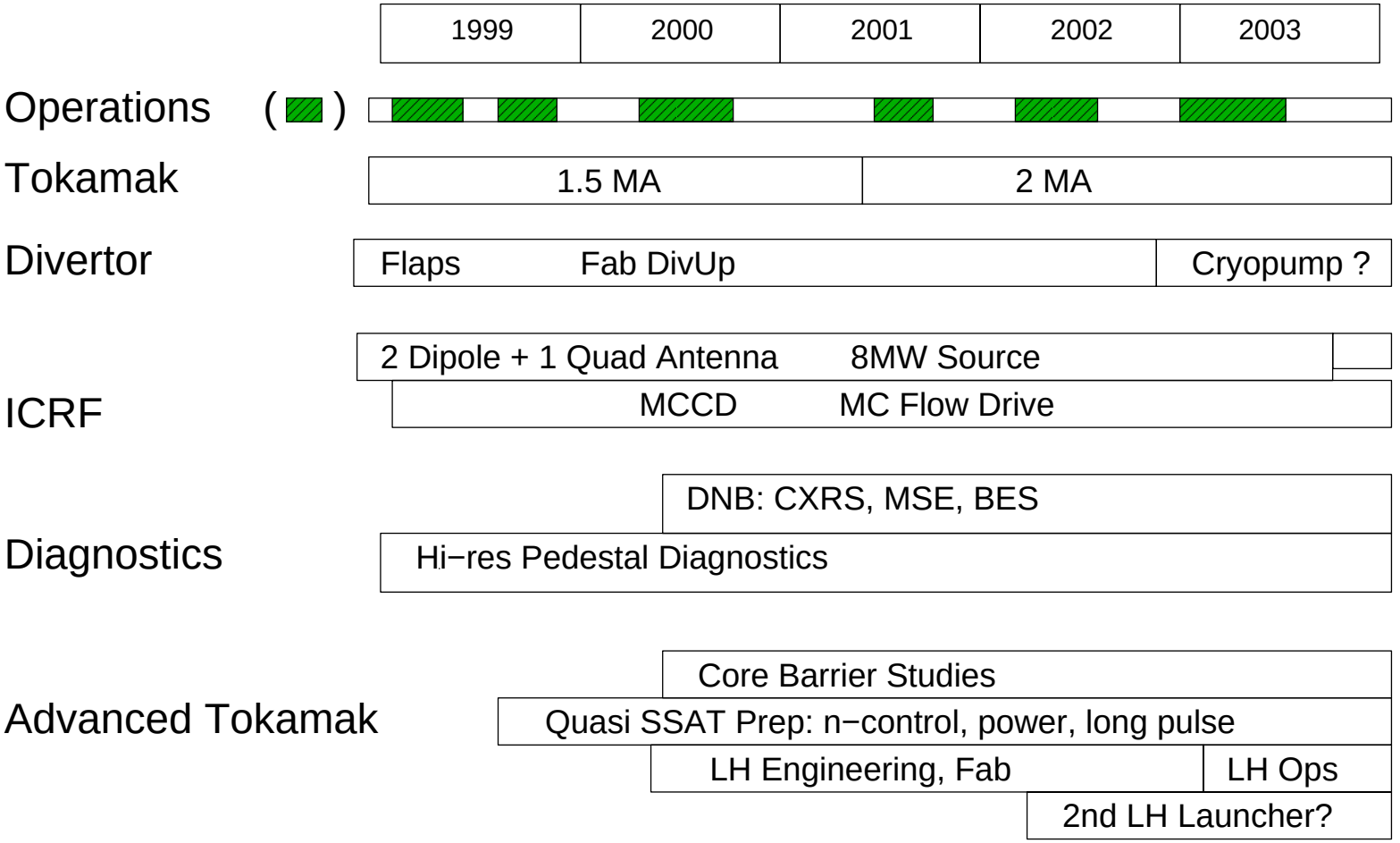


- Sustain adequate research and support staff
  - Maintain a robust near-term research program
  - Assure effective use of the campaigns
  - Increase in graduate student training
- Timely completion of Lower Hybrid Current Drive base project plus second LH launcher
- Implement active divertor cryopumping
- Start of new ICRF antenna design
  - Maintain full ICRF+LH capability
- Increased international collaborations at JET
- Deliver the science for the 5 year FESAC assessment

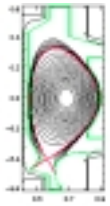
Alcator C−Mod National Facility

Overview Schedule (Mar 2000)





Unique Aspects and Strengths of C-Mod ⇒ Address Key Questions



- Unique long pulse capability (relative to skin and L/R times) in highly shaped, diverted plasma; B > 4 T
  - → Quasi-steady lower hybrid driven AT scenarios
- High field capability to B = 9 Tesla
  - → Address issues for compact, high-field ignition approaches
- Exclusively RF driven
  - – Heating decoupled from particle sources
  - – No external momentum sources
  - → Reactor-relevant regimes for transport, MHD, AT studies
- Unique dimensional parameters, but comparable to larger tokamaks in dimensionless parameters
  - – Key points on scaling curves
  - – Test sensitivities to non-similar processes (radiation, neutrals, etc.)
- Very high scrape-off layer power density
  - – Unique divertor regimes, reactor prototypical
- High Z metal walls (also reactor prototypical)
  - – Unique recycling properties; generic MFE challenge